Minimal Embodiment: Effects of a Portable Version of a Virtual Disembodiment Experience on Fear of Death

Carmen Chan* Northwestern University
Angel Hwang† Virtual Embodiment Lab Cornell University
Daphne Sun‡ Virtual Embodiment Lab Cornell University
Brandon Birckhead§ Cedars-Sinai Medical Center
Andrea Stevenson Won ¶ Virtual Embodiment Lab Cornell University

Abstract

Body ownership illusions are the basis of various virtual reality (VR) applications. However, such illusions frequently require elaborate tracking systems, which make deployment in clinical settings challenging. Therefore, we build on Bourdin and colleagues' former work [3] to trial a virtual out-of-body experience (OBE, individuals view themselves situating outside their physical bodies) with "minimal embodiment." We used a consumer system consisting of a 3 degrees of freedom (DOF) headset and its associated 3 DOF hand tracker. In an exploratory study, we compared participants' fear-of-death (FOD) after undergoing either a control condition (participants remained in control of the avatar body) or a disembodiment condition (participants drifted out of the avatar body and lost visuotactile contact with their avatar). Results revealed an indirect effect of perceived embodiment increasing FOD through a heightened degree of reported OBE in the experimental condition. We discuss limitations and possible extensions of this study, and the future of using simple VR tools in healthcare settings.

Index Terms: Human-centered computing—Human computer interaction (HCI)—Interaction paradigms—Virtual reality

1 Introduction

There is increasing interest in the clinical applications of virtual reality (VR). Early research in this area emphasized the efficacy of VR in exposure therapy [7] where VR helped patients gain a sense of control by allowing patients to feel as though they were present in simulated fear-provoking environments. Besides, VR also showed promise in various clinical contexts, such as treatment for PTSD, schizophrenia, and pain (e.g., [4, 8]). However, despite growing interest, the use of VR in a healthcare setting still has its challenges, including the need for sterilization of equipment, and ease of use for both patients and clinicians. This thus calls for a convenient, easy-to-clean or disposable stand-alone headset.

In order to produce effective interventions in clinical settings, such headsets must often also be able to create a sense of embodiment. For example, participants may need to see their avatar change over time, or perceive their movements as rendered by an avatar. Therefore, it is important to understand what requirements of hardware and software are necessary to create a sense of embodiment sufficient to achieve clinical outcomes. Thus, we undertook a study to investigate the conditions of "minimal embodiment" for clinical applications.

To do so, we extended existing work by Bourdin and colleagues [3]. In the original study, the researchers used an immersive virtual reality system that included head, hand, and feet tracking through real-time motion capture to simulate an out-of-body experience (OBE), where individuals view their body and the world from an perspective outside their physical bodies [1]. In a between-subjects experiment, the OBE condition reduced fear of death compared to a "drifting" body experience (DBE) condition. This experiment used a fairly elaborate system; however, deployment to a clinical setting would eventually require a simpler method for visuotactile stimulation. We thus aimed to translate a similar experience to an inexpensive, standalone headset, and explore how embodiment experiences in this context might affect fear of death. In our study, we recreated this embodied experience with a 3 degrees of freedom consumer headset, the Oculus Go.

*e-mail: cc2434@cornell.edu
†e-mail: hh695@cornell.edu
‡e-mail: ds2354@cornell.edu
§e-mail: brandon.birckhead@cshs.org
¶e-mail: asw248@cornell.edu

2 Methods

Fifty participants were recruited from a large northeastern university and received cash or course credit points for participating.

A few days prior to their arrival at the lab, participants completed a pre-study survey, capturing their baseline fear-of-death and demographic data. Next, participants came to the lab for the experimental session in VR. Figure 1 shows example screenshots of the avatars in the first and second parts of the study. In this session, they experienced visuotactile stimulation modified to work with our consumer set-up, which consisted of a headset with no positional tracking and a single hand controller with only 3 DOF. Our method was inspired by the rubber hand illusion (RHI; [2]). We substituted this method to the one described in the Bourdin paper, in which participants saw virtual balls striking their avatar body.

Figure 1: Screenshots of the study's environment during visuotactile synchrony (left) and the out-of-body phase (right).

Participants were seated and assisted in donning the headset. In the headset, they saw their seated avatar body from the first person perspective, and could also see their reflection in a mirror. In the mirror, the avatar's head movements followed those of the user. Similarly, participants could use the accompanying 3 DOF controller to track the orientation of their hand. However, while participants could rotate their hand at the wrist and see these changes reflected in their avatar hand, positional changes, such as reaching out in space, could not be tracked. We accommodated this limitation by instructing participants to place their right arm on the armrest of the chair while holding the controller. While participants still could not change the position of their hands, they were kept stable by being supported by the armrest.

A pink cloth was positioned in front of their avatar hand. Participants were asked to stroke the cloth by changing the orientation of their hand. As they did so, they felt a physical piece of cloth held in front of their hand in a corresponding position by a research assistant. This created a synchronous visuotactile correlation between the participant's hand touching a physical cloth, and their avatar hand touching the virtual cloth at the same time.

After stroking the cloth, an out-of-body illusion was accomplished in the experimental condition by changing participants' perspective and ending visuotactile synchrony. The participant's viewpoint slowly moved up to the ceiling and behind the avatar. As the viewpoint shifted, the experimenter moved away the cloth that the participant was stroking, causing the participant to lose visuotactile synchrony. At the end of this transition, participants saw themselves from behind and could no longer see their hand moving or feel contact with the cloth. In the control condition, their avatar remained in the chair throughout the entire course of the study.

After removing the headset, participants completed a survey capturing the following measures: Post-study questionnaire using 7-point Likert scales measured participants' perceived *embodiment* [5], *body ownership* (i.e., perceived out-of-body experience) [3], and *fear of death* adopted from the Collett-Lester Fear of Death sub-scale [6]. Additionally, we asked participants to provide written responses on their virtual experience.

3 Results

There are two components of the data analysis in the present study. In the first part, we adopted the formal Bayesian statistical model as used in Bourdin et al.'s original work [3] to test the potential of the experimental condition in reducing fear of death compared to the control condition. In the second part, we examined the mediating and moderating effect of embodiment and body ownership (i.e., perceived OBE) on fear-of-death using Model 7 of PROCESS macro [2]. Analyses were performed with bootstrapping methods, and interaction terms were probed with Johnson-Neyman techniques.

Implementing the Bayesian statistical model, we did not observe reduced fear of death from results of the present study. These results will be discussed in a future paper.

In the second part of the analysis, we revealed a conditional indirect effect of embodiment on participants' fear-of-death with perceived OBE as a significant mediator. Participants' fear-of-death was significantly predicted by embodiment, body ownership, and their experimental conditions, after controlling for participants' demographic data and their baseline fear-of-death (i.e. their reported FOD scores in the pre-study survey) at each mean level. In the OBE condition, participants perceiving a higher degree of embodiment reported increased body ownership, leading to enhanced fear-of-death. However, for participants in the control condition, the conditional mediating effect of embodiment on fear-of-death was not significant. Figure 2 shows summary statistics. We also asked participants to reflect on their experiences throughout the study and provide feedback. In both conditions, participants consistently reported they felt "connected" to the avatar body. Though there was no consensus on whether looking down at their lower body or looking at the reflection in the mirror provided a higher degree of perceived embodiment, participants commonly agreed that seeing a reflection in the virtual mirror as well as feeling the cloth did elicit an increased sense of presence. The qualitative comments regarding the OBE experience are twofold. First, some participants described the experience of floating or elevating from their own avatar body as "scary" or "intimidating." Secondly, a number of participants noticed their avatar no longer mimicked their bodily movements in the OBE condition. As a result, participants stated they "lost control" during the out-of-body phase of the study.

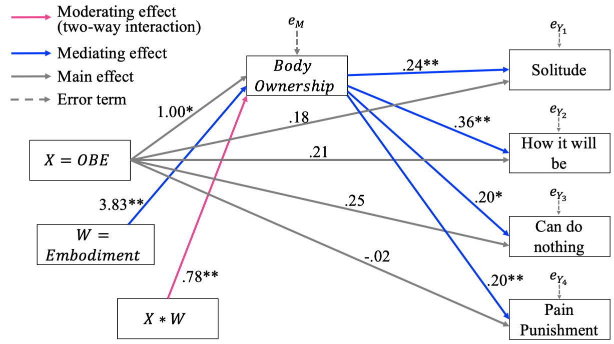

Figure 2: Summary statistics of moderated mediation among OBE, embodiment, and body ownership on fear-of-death. Conditional indirect effect of X on Y_i through $M = (X + X*W)*M$. $M = Bodyownership$, $p^* < .05$, $p^{**} < .01$, $p^{***} < .001$.

4 Discussion

The primary motivation for this study was to examine whether and how a simple consumer set up could create an experience of "minimal embodiment" that could be clinically useful. We tested a portable version of a virtual embodiment experience. Different from the original study, our OBE experience increased fear-of-death in cases where participants reported higher embodiment. However, we were able to replicate aspects of an embodied experience in a 3 DOF VR headset. Participants' qualitative feedback asserted that they found the sense of presence created by a 3 DOF VR headset to be realistic.

Further, additional findings reveal interesting implications for understanding how embodiment may affect some key components of clinical interventions. Of note is fear-of-death being positively mediated by perceived OBE scores when the degree of embodiment is high. We consider this intriguing phenomenon of "withdrawal" from an embodiment experience to have theoretical importance in the field of VR research. Future studies could examine "disembodiment" and the potential outcomes of withdrawal from an embodied avatar.

In conclusion, our results highlight the potential of portable VR for clinical interventions. While we show evidence for the potential of these devices to induce embodied experiences, more work is needed to understand nuances of embodied out-of-body experiences.

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